77TH CONGRESS } HOUSE OF REPRESENTATIVES { DOCUMENT
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LICKING RIVER AT SALYERSVILLE, KY.

LETTER

FROM

THE SECRETARY OF WAR

TRANSMITTING

A LETTER FROM THE CHIEF OF ENGINEERS, UNITED STATES ARMY, DATED MARCH 25, 1941, SUBMITTING A REPORT, TOGETHER WITH ACCOMPANYING PAPERS AND AN ILLUSTRATION, ON A PRELIMINARY EXAMINATION AND SURVEY OF LICKING RIVER AT SALYERSVILLE, MAGOFFIN COUNTY, KY., AUTHORIZED BY THE FLOOD CONTROL ACT APPROVED JUNE 22, 1936

JUNE 11, 1941.—Referred to the Committee on Flood Control, and ordered to be printed with an illustration

WAR DEPARTMENT,
Washington, June 9, 1941.

THE SPEAKER OF THE HOUSE OF REPRESENTATIVES.

DEAR MR. SPEAKER: I am transmitting herewith a report dated March 25, 1941, from the Chief of Engineers, United States Army, on preliminary examination and survey of Salyersville, Licking River, near Magoffin County, Ky., authorized by the Flood Control Act approved June 22, 1936, together with accompanying papers and illustration.

The Bureau of the Budget has been consulted and advises that authorization of the project recommended by the Chief of Engineers would not be in accord with the program of the President at this time.

Sincerely yours,

HENRY L. STIMSON,
Secretary of War.

WAR DEPARTMENT,
OFFICE OF THE CHIEF OF ENGINEERS,
Washington, March 25, 1941.

Subject: Salyersville, Licking River, near Magoffin County, Ky.
To: The Secretary of War.

1. I submit for transmission to Congress my report with accompanying papers and illustrations on preliminary examination and survey of Salyersville, Licking River, near Magoffin County, Ky., authorized by the Flood Control Act approved June 22, 1936.

2. Salyersville is the county seat of Magoffin County, Ky., and is located near the center of the county, on Licking River, 275 miles above its confluence with the Ohio River, opposite Cincinnati, Ohio. Salyersville is on the right (north) bank of the river, on the outside of a horseshoe bend, just below the entrance from the same bank of two tributaries, State Road Fork and Burning Fork. Agriculture, mostly confined to the narrow river bottoms, is the principal pursuit. Some coal and petroleum are produced in Magoffin County above Salyersville. The 1930 census gave the population of the town as 446, but a figure of 1,750 is now claimed. The population of the entire basin above Salyersville is estimated at 5,700. There are no railways in the area, but four State highways center at Salyersville. No local works for flood protection have been constructed and no project for navigation or flood control in this district has been authorized by Congress.

3. Flash floods occur in Salyersville from one to three times in 1 year. The average frequency is about twice per year. The two tributaries which enter the river at the upper limits of the town are capable of causing flood damage when the river itself is not in flood. Floodwaters become engorged below the town, so that the damage is caused by backwater from this constriction rather than from current action. The high water covers the lower floors of dwellings and store buildings and causes damage to floors, furniture and merchandise. Floodwaters concentrate very rapidly and frequently without sufficient warning to enable merchants and householders to move their property to upper floors or shelves above flood levels. The worst flood of record occurred in February 1939, with a river discharge of 14,000 cubic feet per second. Property damages from this flood, based upon a canvass from house to house, are estimated at $39,300. Average annual direct damages are estimated at $9,000 for the 13-year period of record. Indirect damages capable of approximate evaluation increase this to $11,000. Local interests desire protection from floods by means of a diversion cut-off across the throat of the bend upon which the town is located and by channel improvement. There is no responsible local organization that can guarantee local cooperation. It is believed, however, that voluntary contributions in sufficient amount to provide the necessary rights-of-way and other essentials of local cooperation would be forthcoming.

4. The district engineer finds that evacuation and resettlement of the portions of Salyersville that are subject to flooding is not practicable economically. He finds that a cut or tunnel across the throat of the bend on which the town is located will not solve the problem, as backwater from such a diversion would rise above flood levels and floods on State Road Fork and Burning Fork capable of causing much

damage would not be controlled. He reports that flood protection for Salyersville can best be provided by construction of levees along the north banks of State Road Fork and Licking River with a pumping plant to evacuate local drainage. The total first cost is $186,000, of which the Federal first cost is $174,000 and the non-Federal first cost is $12,000. Annual charges are estimated at $9,500 and the annual benefits are $12,300. The district engineer considers the project to be economically justified and he recommends its construction at an estimated first cost to the United States of $174,000. The division engineer points out that in order to save on the cost of installation, the proposed pumping plant is designed to evacuate interior drainage at a slower rate than that at which it would accumulate and that resultant damage from interior ponding would reduce the estimated annual benefits by $600, but he concurs in recommending the improvement.

5. The Board of Engineers for Rivers and Harbors, concurring in general in the views and recommendations of the district and division engineers, finds that floods at Salyersville, Ky., can best be controlled by means of levees and a pumping plant. The Board recommends construction of the above works at a first cost to the United States of $174,000, subject to certain conditions of local cooperation.

6. After due consideration of these reports, I concur in the views of the Board. Floods on Licking River at Salyersville are frequent and have caused substantial property damage. Protection against floods of experienced magnitude can be afforded by construction of levees and a pumping plant. I recommend construction of levees and a pumping plant for the protection of Salyersville, Ky., substantially as outlined in the report of the district engineer, at an estimated first cost to the United States of $174,000; subject to the provision that responsible local interests give assurances satisfactory to the Secretary of War that they will provide without cost to the United States all lands, easements, and rights-of-way necessary for the construction of the project, all necessary road pavement at levee crossings, and the drainage facilities necessary to concentrate interior run-off at the pumping plant; that they will hold and save the United States free from claims for damages due to the construction of the project; and that they will maintain and operate all the works after completion in accordance with regulations prescribed by the Secretary of War.

J. L. SCHLEY,
Major General,
Chief of Engineers.

REPORT OF THE BOARD OF ENGINEERS FOR RIVERS AND HARBORS

[Second endorsement]

THE BOARD OF ENGINEERS FOR RIVERS AND HARBORS,
Washington, D. C., January 27, 1941.

To the CHIEF OF ENGINEERS, UNITED STATES ARMY:

The Board concurs in general in the views of the district and division engineers. Frequent floods on Licking River have caused substantial property damage at Salyersville, Ky. Protection against

floods of past record can best be provided by construction of levees along the north banks of State Road Fork and Licking River, with a pumping plant for the evacuation of interior run-off. The plan will include drainage facilities for the concentration of this interior flow at the pumping station and the paving of highway ramps across the levees, all of which work in the opinion of the Board should be the responsibility of local interests. The Board recommends construction of levees and a pumping plant for the protection of Salyersville, Ky., substantially as outlined in the report of the district engineer, at an estimated first cost to the United States of $174,000; subject to the provision that responsible local interests give assurances satisfactory to the Secretary of War that they will provide without cost to the United States all lands, easements, and rights-of-way necessary for the construction of the project, all necessary road pavement at levee crossings, and the drainage facilities necessary to concentrate interior run-off at the pumping plant; that they will hold and save the United States free from claims for damages due to the construction of the project; and that they will maintain and operate all the works after completion in accordance with regulations prescribed by the Secretary of War.

For the Board:

THOMAS M. ROBINS,
Brigadier General, Corps of Engineers,
Senior Member.

SURVEY OF LICKING RIVER AT SALYERSVILLE KY.

SYLLABUS

The district engineer finds that an aggravating flood situation exists at Salyersville, Magoffin County, Ky., near the headwaters of the Licking River. Two floods have occurred within the past 13 years which have inundated practically the entire town. Minor floods occur approximately twice each year. The development within the area subject to flooding consists of the business district, and the residences of about 500 of the town's inhabitants. The district engineer finds that alleviation of the flood situation at Salyersville by means of levee protection is feasible for the main portion of the town. He concludes that construction of levees to protect against a flood equivalent to a discharge of 14,000 cubic feet per second on the Licking River below State Road Fork, with a freeboard of 3 feet, is justified.

The district engineer recommends the construction of levee protection at Salyersville at a total estimated Federal expenditure of $174,000, and that local cooperation be required to the extent of providing all necessary rights-of-way, drainage facilities to the pumps, road changes, and maintenance and operation subsequent to completion of the works.

WAR DEPARTMENT,
UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, March 30, 1940.

Subject: Flood-control survey at Salyersville, Licking River, Ky.

To: The Chief of Engineers, United States Army.
[Through the Division Engineer, Ohio River Division.]

I. INTRODUCTION

1. *Authority.*—This investigation is authorized by the Flood Control Act of 1936, Public No. 738, Seventy-fourth Congress, second

session, approved by the President June 22, 1936, which states in part as follows:

* * * * * * *

SEC. 6. The Secretary of War is hereby authorized and directed to cause preliminary examinations and surveys for flood control at the following-named localities: * * *

* * * * * * *

Salyersville, Licking River, near Magoffin County, Kentucky,

* * * * * * *

In the preliminary examination which was made as prescribed by law and reviewed by the Board of Engineers for Rivers and Harbors, the district engineer found that flood relief for the town of Salyersville was feasible and of sufficient merit to warrant a detailed survey. The Chief of Engineers, upon the recommendation of the Board of Engineers for Rivers and Harbors, authorized, on April 5, 1938, a survey to be made at Salyersville, Licking River, Magoffin County, Ky., to determine a plan of protection and the estimated cost thereof.

2. *Prior studies.*—The report on Licking River, Ky. (H. Doc. No. 86, 73d Cong., 1st sess.), prepared under authority of the River and Harbor Act of January 21, 1927, in accordance with House Document 308, Sixty-ninth Congress, first session, and under authority of section 10 of the Flood Control Act approved May 15, 1928, was the only report previous to the above-cited preliminary examination which considered the flood problem of the Licking River. This report considered the possible development of flood-control measures, power, navigation, and irrigation, individually or in combination. Relative to the immediate site of Salyersville, Ky., it was found that the most feasible and economical means of protecting this town was by the construction of levees. In view of the excessive costs compared to the benefits to be derived, the construction of levees at Salyersville was not recommended at that time. For similar reasons, no flood control or other development was recommended in any portion of the basin.

3. *Purpose.*—The purpose of the survey at Salyersville is to determine what measures, if any, shall be provided for protection against the floods which harass the citizens of that community and the estimated cost of those measures.

4. *Scope of study.*—The scope of this report is limited to an analysis of the flood problem at Salyersville, Ky. The study presented herein is based upon a detailed flood-damage survey, a topographical survey, foundation investigations by means of auger borings, hydrological investigations, and preliminary design of protective works. The study is sufficiently comprehensive to permit the selection of the most feasible plan of flood protection.

5. *Maps.*—In 1930 a topographic survey was made of Salyersville, and this information was used in preparing the report of 1931 (H. Doc. 86, 73d Cong., 1st sess.) and the preliminary examination report of 1938. The 1930 topographic map, with scale 1 inch equals 100 feet and 1-foot contour interval, was revised in 1939 to show new buildings, new utility-transmission lines, channel changes, and to correct to United States Coast and Geodetic Survey datum. The new datum is 10.72 feet higher than that used previously. It was also extended to a somewhat higher elevation back from the river. Soundings were taken to ascertain changes in channel sections, silting, and scouring,

which had occurred in the intervening 9 years since the first map was made. United States Geological Survey maps of small scale (1:125,000) and large contour interval (100 feet) are available for study of the entire watershed above Salyersville.

II. GENERAL DESCRIPTION

6. *Licking River Basin.*—The Licking River rises in Magoffin County in southeastern Kentucky and flows 320 miles in a general northwesterly direction to enter the Ohio River opposite Cincinnati, Ohio, 470.2 miles below Pittsburgh. Its watershed of 3,672 square miles lies wholly within the State of Kentucky. The greater axis of this diamond-shaped basin (i. e., from source to mouth), is approximately 135 miles long and the lesser axis (normal to the general direction of the river and roughly midway between its source and mouth), is about 50 miles. The basin comprises all or parts of 23 counties (see plate 1).[1] The basin is hilly to mountainous almost throughout. In the upper portion the hilltops are 500 to 700 feet above the main stream bed and in the lower are from 200 to 500 feet. Practically no flat land exists except in the narrow valley bottoms. Throughout the lower 100 miles of its course, the Licking River is entrenched in a well-developed alluvial terrace whose general level varies from 70 to 100 feet above low water. The height of this terrace above the stream, decreasing toward the headwaters, reaches and intersects the flood plain in the vicinity of Blue Lick Springs.

7. *Licking River Basin above Salyersville.*—At Salyersville, Ky., two tributaries, State Road Fork and Burning Fork, join the Licking from its right bank at points not over 600 feet apart and immediately upstream from the business center of town. The watershed of the Licking River above Salyersville is 109 square miles in extent (including State Road and Burning Fork). It is rough and mountainous. The hilltops rise 300 to 500 feet above the stream bed. The ascent from the stream banks to the hills is rapid and the valleys are short and steep. The most part of the watershed is covered with second-growth timber struggling for existence on the eroded hillsides. The narrow valley bottoms and such of the hillsides as retain top soil are farmed. The majority of the produce is consumed locally in the self-support of the producers. The watersheds of State Road and Burning Fork, having approximate areas of 14 and 12 square miles, respectively, are of similar character.

8. *Geology.*—The Licking River Basin is underlain by sedimentary rocks of the Paleozoic era extending in stratigraphic sequence from Middle Ordovician through Silurian, Devonian, and Mississippian into the Pennsylvanian period. The Lexington series of the Middle Ordovician system are limestone strata of medium thickness. The Cincinnatian series of Upper Ordovician comprise alternate thin beds of limestone and shale. The Silurian and Devonian systems consist principally of shales. The Mississippian system is chiefly sandy shales and sandstone, but has a topping limestone formation varying from 0 to 150 feet in thickness. The Pennsylvanian system in this area is conglomerate, sandstone, coal, and sandy shales. The basin is intersected somewhat at right angles near its lower one-third point

[1] Not printed.

by the Cincinnati Arch, a major upfold in the rocks extending northeast from Nashville, Tenn., and crossing the Ohio River some distance above Cincinnati. By reason of this geologic structure, the dip of the rocks brings to the surface in sequence the various formations. The lower third of the Licking River Basin exposes the Cincinnatian or Upper Ordovician rocks, the middle third exposes the Middle Ordovician, Silurian, Devonian and Mississippian, and the upper third of the basin exposes the Pennsylvanian strata. By reason of its location in the upper one-third of the valley, well to the side of the Cincinnati Arch, the town of Salyersville and the watershed above it are underlain by the Pennsylvanian strata containing sandstone, conglomerate, coal, and sandy shale. Minor faults have been found in various parts of the whole Licking River Basin but these are estimated to be of little significance with reference to ordinary engineering design and construction. Auger borings made at Salyersville just back of the banks and in the flood plains of the Licking River and State Road Fork reveal sand at 9 to 16 feet below the ground surface (see plate 5).[1] Covering the sand is alluvial material of clayey silt interspersed with quicksand. This silty blanket above the sand is variable in thickness and very pervious. The ground water table, therefore, fluctuates rapidly with changes in river stage and for the most part, slopes rather steeply upward away from the river channel.

9. *General development.*—The entire Licking River Basin is predominantly rural, agriculture being the principal pursuit. The timber resources, once of considerable value, are now largely exhausted. The only industries are located near the mouth of the Licking River. Salyersville, located 275 miles above the mouth of the river, is a town of 1,750 population by local claim (official 1930 census indicates a population of 446). The larger figure includes the entire town and its outskirts. That portion of the town lying to the north of the Licking River and subject to flood damages, represents about 500 people. In this sector of town is located the business district, with one large new school building, the courthouse of Magoffin County, Ky., two small hotels, one bank, four churches, mercantile stores, and tradesmen's shops. The residences of this sector range from substantial homes to small pile-supported dwellings, the latter being located between State Road Fork and Kentucky State Highway No. 40. The town owes its origin to the timber industry which, though now practically abandoned on account of exhausted resources, might, under an adequate program of reforestation, again become important in the export of forest products. In Magoffin County, of which Salyersville is the county seat, there are known to exist as many as 10 coal seams of workable thickness. The major coal deposits occur near the extreme headwaters of the Licking River. Coal in commercial quantities was not produced in Magoffin County until as late as 1923. By 1927 the annual production had amounted to as much as 222,208 tons according to the annual report (p. 128) of the chief mine inspector of Kentucky for that year. At the present time, however, only one mine is operating on a basis sufficient to export coal. Other than this, there exist only small hillside workings supplying local needs. The production of crude oil in the area above Salyersville reached its peak in 1923. Undoubtedly, the oil industry

[1] Not printed.

in Magoffin County was principally responsible for the growth of the town of Salyersville to its present size. At the present time, although 15 companies operate a total of approximately 1,200 wells in the county, the annual output is less than 8,000 barrels as contrasted to an annual production of 1,348,623 barrels reported for 1923. Probably because of the inaccessibility of the region above Salyersville, no major exploitations have been made for iron ores, sandstone, and fire clay which are known to exist in the Licking Basin.

10. *Population.*—The population of the town of Salyersville from 1890 to 1930, as shown by the United States census, is as follows:

Year	*Population*	*Year*	*Population*
1890	339	1920	412
1900	265	1930	446
1910	310		

The figure of 1,750, now claimed, has been brought about by an extension of the city limits to include outlying residential areas. On the basis of 52 persons per square mile (the 1930 census quotation for Magoffin County), the total population of the combined watersheds of the Licking River, State Road Fork, and Burning Fork above Salyersville is estimated at about 5,700 persons.

11. *Highways.*—The main highway serving Salyersville is Kentucky State Highway No. 40, providing connections generally to the east and west. Intersecting State Highway No. 40 in Salyersville is State Highway No. 30 from the southwest, and State Highways Nos. 7 and 114 from the southeast. State Highway No. 40 is a macadamized all-weather road. State Highways Nos. 7, 30, and 114 are semisurfaced all-weather roads.

12. *Railroads.*—There are no railroad lines serving Salyersville. The nearest railroad is a branch line (Dawkins subdivision) of the Huntington Division of the Chesapeake & Ohio Railway Co. This branch line terminates at Carver and crosses the Licking River at Royalton about 6 miles above Salyersville.

13. *Waterway.*—The Licking River is considered to be navigable to a point 3 miles above its mouth. Salyersville is about 270 miles above the head of navigation. Any use to which the Licking River and its tributaries above Salyersville may have been put for rafting logs during lumbering operations of an earlier period has been discontinued.

14. *Air.*—No air lines serve Salyersville nor are there any emergency landing fields in the vicinity.

15. *Bridges.*—There are two highway bridges on State Highway No. 7 in Salyersville, carrying it over Burning Fork and State Road Fork. There is one bridge across Licking River on the street leading from State Road No. 7 to the residential district known as Dixie. State Highway No. 30 crosses the Licking River at a bridge located somewhat downstream (southwest) from the main business district of Salyersville. All four of these bridges have floor levels below the flood stage reached in the February 1939 flood (maximum flood of record).

16. *Flood-control improvements.*—There are no existing flood-protection works at or above Salyersville, Ky.

III. METEOROLOGY, HYDROLOGY, AND FLOOD HYDRAULICS

17. *General.*—The meteorological, hydrological, and hydraulic studies incident to this report provide a basis for the development of a flood-control plan for Salyersville, Ky. Due to meager data available on rainfall and stream flow in this area, the results herein cannot be considered absolutely conclusive. Fortunately, however, during the course of this study, the maximum flood of record occurred. Reliable rainfall data were obtained by means of an automatic rain gage, and stream-discharge data by actual observations, were secured for this flood. These data and an analysis of rainfall and stream flow records for the lower portions of the Licking River Basin, have formed essentially the basis for the derivation of the design flood. It is believed that the results obtained herein are sufficiently accurate to determine the most feasible type of protection and the economic justification therefor.

18. *Average annual and monthly precipitation.*—The closest station to Salyersville, namely, Paintsville, is located approximately 15 miles to the east. For mean monthly precipitation analyses, data from eight stations within a 40-mile radius of Salyersville have been utilized. These stations, their years of record, and mean monthly rainfalls are listed below.

TABLE 1.—*Average precipitation in inches*

	Farmers	Paints-ville	Preston-burg	Quick-sand	Jackson	Pippa-pass	Pike-ville	Hazard
Years of record	31	6	8	13	16	6	33	16
January	4.60	4.96	3.14	4.49	4.81	3.84	3.90	3.81
February	2.94	3.12	3.32	3.41	3.03	2.96	3.56	3.21
March	4.76	5.51	4.00	5.61	4.47	4.13	4.47	4.31
April	3.95	3.79	3.38	4.44	3.67	3.53	3.95	3.88
May	4.00	4.43	4.20	4.77	3.80	3.43	3.75	5.13
June	4.36	3.74	3.95	3.92	4.47	4.16	4.04	4.35
July	4.69	5.74	3.98	6.02	4.99	5.48	4.44	5.27
August	4.59	5.00	4.53	4.75	3.71	4.32	4.28	4.59
September	2.93	3.84	2.27	3.65	2.65	3.68	2.88	2.87
October	2.95	2.12	3.31	3.35	3.27	3.12	2.76	3.02
November	3.00	2.64	3.19	3.99	3.16	2.63	2.88	3.20
December	3.69	3.11	3.21	3.90	4.11	3.45	3.54	3.98
Annual	46.46	48.00	42.48	52.30	46.14	44.73	44.45	47.62

In the above table, the years of record are computed to and including December 1938 for all stations except Prestonburg whose period of record terminated January 1933.

19. *Maximum and minimum monthly precipitation.*—The greatest monthly precipitation recorded at the above stations occurred at Quicksand in July 1938 and amounted to 15.43 inches. Prior to this extreme precipitation, the maximum monthly precipitation was 12.02 inches and occurred at Hazard in June 1935. The minimum monthly precipitation occurred at Pippapass, Ky., in October 1938 with no rainfall.

20. *Snowfall.*—No storm snowfall records are available in the vicinity of Salyersville. The Salyersville Independent, in its issue of Friday, March 20, 1936, refers to "a record snow of 13 inches" as having just fallen. The maximum depth of snowfall at Knoxville,

Tenn., occurred on December 6, 1886, and amounted to 22.5 inches. The corresponding record at Cincinnati occurred on January 22, 1918, and amounted to 13.5 inches. The average monthly snowfall at 6 stations in the vicinity of Salyersville is given below.

TABLE 2.—*Record of snowfall*

Station	Years of record	Average monthly snowfall in inches						
		October	November	December	January	February	March	April
Beattyville, Ky.	35	0.77	1.09	3.62	4.92	4.51	2.44	2.86
Farmers, Ky.	30	.40	2.49	3.07	4.40	3.69	1.50	.07
Mount Sterling, Ky.	41	.09	.70	3.80	5.78	5.81	3.19	2.49
Logan, W. Va.	28	.14	2.00	4.10	4.83	6.47	3.80	.71
Dante, Va.	20	.40	.71	3.02	3.76	3.41	1.74	.67

21. *Maximum 1-day precipitation.*—Maximum precipitations recorded for a 1-day period are given in the following table. Unofficial measurements for the cloudburst of July 5, 1939, over portions of the area covered by the listed stations are not included.

TABLE 3.—*Maximum 1-day precipitation*

Station	Precipitation, inches	Date of occurrence	Station	Precipitation, inches	Date of occurrence
Farmers	4.95	Apr. 30, 1909	Pippapass	2.90	Dec. 12, 1931
Paintsville	4.13	Sept. 3, 1936	Pikeville	3.80	Oct. 22, 1929
Prestonburg	3.10	July 25, 1926	Hazard	4.51	May 30, 1927
Jackson	4.44	June 12, 1923			

22. *Short duration precipitation.*—Short-time duration precipitation recorded by the Salyersville rainfall gage (installed on December 20, 1938), is as follows:

TABLE 4.—*Short duration precipitation*

Duration, hours	Intensity, inches	Date of occurrence	Duration, hours	Intensity, inches	Date of occurrence
1	2.30	July 5, 1939	12	3.78	July 5, 1939
2	2.80	Do.	24	3.78	Do.
6	3.73	Do.			

Although only 3.78 inches of rainfall were recorded at Salyersville for this storm, reasonably reliable information obtained at a Civilian Conservation Corps camp near Morehead, Ky. (see pl. 1)[1] about 35 miles to the northwest, is to the effect that the total rainfall for the same storm amounted to about 7.35 inches, almost all of which fell in a period of 1.5 hours. Less reliable information obtained at Paxton, Ky. (in the Kentucky River watershed), about 20 miles to the west, indicates that the intensity of the storm was very materially greater at that locality. It is conceivable that this storm could have centered over the Salyersville area.

[1] Not printed.

23. *Average monthly temperature.*—The average monthly temperature at the various stations in the vicinity of Salyersville are given in the following table:

TABLE 5.— *Average monthly temperature*

Month	Station			
	Beattyville, Ky.	Farmers, Ky.	Dante, Va.	Williamson, W. Va.
Years of record	35	30	31	38
January	36.1	35.6	35.3	36.9
February	37.4	36.6	38.7	37.4
March	46.6	45.1	45.4	46.7
April	55.2	54.5	54.0	55.6
May	64.2	63.1	61.9	65.2
June	72.6	71.4	69.2	72.9
July	76.2	73.8	72.2	75.5
August	75.2	74.4	70.4	75.0
September	68.8	68.4	67.4	69.8
October	57.5	56.7	55.9	58.1
November	45.5	45.3	45.0	45.5
December	47.0	36.8	38.1	37.7

24. *Stream-flow records.*—A stage-recording gage was established at Connelley Bridge (sometimes called Jackson Bridge), immediately below Salyersville, on February 27, 1939. A nonrecording gage was installed at the same location on December 20, 1938. The drainage areas above Salyersville and Connelley Bridge are 109 and 110 square miles, respectively. A stage-recording gage was also established on State Road Fork near the upper corporation limits of Salyersville on February 17, 1939. The drainage areas above the gage and the mouth of State Road Fork are 13.2 and 13.8 square miles, respectively. This gage is within the range of backwater effect from the Licking River during flood periods. These two gages constitute the only gages on the Licking River at and above Salyersville. There are no other gages in the vicinity for comparable drainage areas. Although the periods of record of the two Salyersville gages are short, the State Road Fork rating curve is well defined to bank-full stage and the Connelley Bridge rating curve is well defined for the full range of discharges of the February 1939 flood during which measurements were made. The maximum discharge for this flood occurred on February 3 and amounted to 14,000 cubic feet per second. The maximum discharge from State Road Fork subsequent to the installation of the gage occurred on July 5, 1939. By extension of the rating curve, this flow was estimated to have been 4,400 cubic feet per second.

25. *Physical features affecting floods.*—Obviously, the physical features of the Licking River watershed at and above Salyersville have a definite effect on flood flows at Salyersville. The various factors to be considered in this connection are discussed immediately below.

26. *Shape and character of the basin.*—The Licking River rises in the acute angle formed at the junction of the watersheds of the Big Sandy and the Kentucky Rivers. The folds in the stratified rocks which form these latter watersheds, are so near each other that the intervening basin drained by the Licking, has little width. The basin has a drainage area of 109 square miles above Salyersville (including Burning Fork and State Road Fork), is roughly 20 miles in

length, and is triangular in shape, with Salyersville located at the center of its base. Such a shape is conducive to flashy run-off.

27. *Tributaries.*—Two tributaries, State Road Fork and Burning Fork, enter the Licking River at Salyersville. (See plate 2.) The confluence of State Road Fork with the Licking River is located at the middle of a bend in the Licking River. Salyersville proper is located in the flood plain at the outside of their junction. Approximately 600 feet upstream from State Road Fork, Burning Fork enters the Licking River. While the drainage areas of these tributaries are small, their run-off is flashy and they contribute appreciably to the flood problem of the town. In fact, it is reported that these two tributaries in themselves flood Salyersville.

28. *Slope of the basin.*—The Licking Basin is mountainous in character and eroded into a complicated system of main and minor ridges and spurs, among which the many tributaries rise. The ascent to the ridges from the stream bottoms is rapid and the courses of run-off are seldom longer than 0.5 mile. The rise from the stream bottoms to the ridges is between 300 and 500 feet.

29. *Slope of stream.*—The slope of the Licking River above Salyersville is steep and continually increasing to the headwaters, 30 river miles upstream. The average slope is 0.002 or approximately 10 feet per mile. The river slope in the vicinity of Salyersville is 0.00065 except in the bend at Salyersville where there is a decrease in slope to 0.00048. State Road and Burning Fork maintain an average slope of 0.002 to 0.5 mile above their mouths. Their average rises to their headwaters are 9.50 and 8.85 feet per mile, respectively.

30. *Character of soil covering.*—The soil covering over the basin is relatively thin as indicated by the rock outcropping and the short duration of flow of the numerous seepage springs. The ability of the soils to effect the run-off is small and such retention as is present, is attributed to the timber covering.

31. *Flora covering.*—The majority of the area in the basin is covered with second growth timber. The narrow bottom lands and the hillsides, where possible, are under cultivation. The inhabitants are a strictly farming population and the larger portion of their produce is consumed in their own support.

32. *Natural storage.*—The nature of the Licking River as a whole, is not conducive to valley storage of flood flows. The main river and tributary valleys are deeply eroded. The valley bottoms, which are the channels for flood flows, vary from 50 to 160 feet in width along the main river. The normal flow channel, whose width varies up to 35 feet, overflows the sandy and irregular banks with a rise of 5 to 7 feet. Since the nature of the run-off is flashy, overbank flooding is frequent but of short duration. The only factors affecting valley storage are the occurrence of gorge or narrow sections and the winding and meandering course of the stream. The occurrence of flood gorging above Salyersville is not critical. However, such effect immediately below Salyersville is believed to be largely responsible for the frequent flooding of that town. The Licking River is notably meandering throughout its entire course of flow. However, such winding is greatest between Salyersville and West Liberty. The series of bends of which the Salyersville bend is a part is 4.0 miles long as measured by the course of the stream while the direct distance across them is but 1.1 miles.

33. *Effect of physical features.*—The general nature of the basin, including its shape, ruggedness, short distance of run-off travel, slope, and imperviousness is conducive to flashy run-off. The slight tendency toward gorging below Salyersville is believed to contribute to the frequent flooding at Salyersville.

34. *Storm paths.*—The paths of the storm movements over the upper Licking River are comparable to those over the whole Ohio Valley. The general paths of storms are from west to east, and a study of their relative axes shows a definite Parallelism existing between them. In their general trend the Ohio Valley storms follow close to the Ohio River. However, there are instances where major storm paths have approached the northern or southernmost boundaries of the Ohio Basin. The result of a study made by the United States Weather Bureau relative to these storm axes indicates that their location is influenced by the line of discontinuity between the conflicting air masses set in motion by barometric pressures over the Atlantic Ocean. Coincidental with a low barometric pressure, a southerly location of storm axis may be expected. The storm of February 3, 1939, causing the highest flood stage of record at Salyersville, was a storm of southern axial location. A study made by the United States Weather Bureau indicates that it is improbable that excessive precipitation will occur when the ground is covered with an appreciable depth of snow. The study indicates that run-off from snow cover would be at the rate of 0.06 inch per hour during unusually excessive precipitation.

35. *Past storms.*—As indicated in paragraph 17 above, reliable and comprehensive data on rainfall and stream flow for Salyersville are not available. Two storms of more than usual magnitude have occurred since the recording rainfall gage and stream flow gages have been operative. In the storm of February 3, 1939, 2.6 inches of rainfall were recorded in 12 hours, of which 2.2 inches fell in less than 8 hours. Stream discharge observations were made in both State Road Fork and the Licking River for the flood which resulted from this storm. Another storm occurred on July 5, 1939, in which 3.78 inches of rainfall were recorded in a 12-hour period, and 2.30 inches in 1 hour. Although stream-gage records are available for the resulting flood, no actual discharge observations were made. Other minor storms have occurred during the short period of record of the gages.

36. *Analysis of available rainfall and stream-flow data.*—The time of concentration of State Road Fork and the Licking River, as obtained from a study of the records, is 3 hours and 12 hours, respectively. It is estimated that the time of concentration of Burning Fork with its drainage area of 11.75 square miles, is between 2.5 and 3 hours. That portion of the total basin run-off yet to pass Salyersville 48 hours after the rain has ceased, is of small consequence. The hydrograph at Salyersville is practically depleted 72 hours after the rain has ceased to fall. Thus, 2- and 3-day lapses in rainfall periods create run-off hydrographs wholly independent of each other. This indicates that long duration winter storms are less effective over this drainage area than larger individual storms farther downstream. Since the Connelley Bridge recording gage was established on February 27, 1939, the period of stream-flow records from which to produce a unit hydrograph is exceedingly short. The few storms occurring during the period of record of this gage have been of such duration

as to require considerable "breaking down" of the flood hydrograph in the production of unit graphs. The varied results obtained indicate that no reliable correlation in run-off analysis can be obtained until a greater amount of data becomes available. Likewise, the short period of record of gage heights (and corresponding flows) precludes the analysis of frequency of flood flows. Therefore, it becomes necessary to analyze the frequency of flood flows at other points for which more data are available and apply the results of that analysis to Salyersville.

37. *Flood frequencies.*—Frequency studies for gaging stations having comparatively long periods of record provide data from which type curves of frequency of discharge versus drainage area can be constructed. These curves establish the regime of discharges for given frequencies. Discharge frequency for ungaged areas of similar character can be interpolated therefrom. In these studies, it is believed that such a set of frequency curves established for the whole Licking River will provide rational values of frequency of discharge when adapted to the Salyersville drainage area. The only stations on the Licking River having gaging-station records of a sufficient duration for the computation of discharge frequencies are Farmers and Falmouth. Frequency curves for these stations were derived and extended to the Salyersville area of 110 square miles, with the following results:

Frequency in years	0.33	0.50	0.75	1.0	5.0	10.0	5.0	100.0
Stage in feet, mean sea level	846.7	847.9	848.8	849.3	851.2	851.7	853.1	853.8
Discharge in cubic feet per second	1,080	1,660	2,370	2,880	6,210	7,900	11,700	13,200

Details of the above study are contained in appendix A.[1]

38. *Maximum probable flood.*—It is conceivable that a flood materially greater than the maximum of record could occur. Careful analysis and study of a large number of maximum probable peak discharges computed for other projects involving reasonably comparable drainage areas and located in watersheds relative to which more data are available indicates that a fairly consistent relationship obtains between maximum probable discharges and drainage areas. By comparison with general envelope curves denoting this relationship it is estimated that the maximum probable flood flow from the Licking River and tributaries above Salyersville is between 40,000 and 50,000 cubic-feet per second.

39. *Design flood.*—Previous studies have contemplated the adoption of a design flood of 10,000 cubic feet per second, which was estimated to be 1,300 cubic feet per second in excess of the previous flood of record (May 1927). However, estimates based upon the recently established rating curve for the Connelley Bridge gaging station indicate that the May 1927 flood had in fact a peak discharge of about 11,000 cubic feet per second. The elevation of the February 1939 flood (maximum of record) at the junction of the Licking River and State Road Fork was only 1.2 feet higher than that of May 1927, whereas the discharge (14,000 cubic feet per second) was about 27

[1] Not printed.

percent greater. Based upon the relationship between stage elevations at Connelley Bridge and at Salyersville and on the rating curve for Connelley Bridge gaging station (see exhibit 1 of appendix A),[1] it is estimated that a discharge of 20,000 cubic feet per second would result in an elevation about 2 feet higher than that of February 1939. As indicated in paragraph 37 above, the maximum flood of record has a probability of occurrence of less than once in 100 years. In view of that fact, a design flood of 14,000 cubic feet per second is selected. As will be shown later, the only feasible method of flood protection is levee construction. Since the freeboard allowance (3 feet above confined design flow at 14,000 cubic feet per second) will permit the passage of a flow almost 50 percent greater than the design flood and still have a freeboard of 1 foot, it appears entirely adequate. Protection against the maximum probable flood (see par. 38 above) is, of course, impracticable. As will be shown later (see par. 69 below), protection against a design flood of 14,000 cubic feet per second with 3-foot freeboard is at the approximate peak of economic feasibility.

40. *Influence of protective works on Licking River flood flow.*—The confinement of Salyersville proper by local protective works would create little effect upon the water surface slope of the flood flows of the Licking River. The area occupied by the town is in excess of the average channel area of flow in this vicinity. It is conservatively estimated that for a flood analogous to that of February 1939, the effect of flow confinement due to levees would be to raise the water surface elevation at the mouth of State Road Fork approximately 0.5 foot.

41. *Influence of protective works on State Road Fork flood flow.*—It is reliably reported that flood crests from State Road Fork always precede those from the Licking River and that stages from the latter exceed those from State Road Fork. The design flood would have caused no increase in water surface along State Road Fork, other than that caused by confinement of Licking River flows (see par. 40 above). However, since the peak flow of State Road Fork in the February 1939 flood was not exceptionally great, it is believed that allowance in freeboard should provide for the occurrence of much greater flows from State Road Fork coincident with the design flow in the Licking River. It is conservatively estimated that if a discharge of 7,000 cubic feet per second (assuming a peak flow of about 500 cubic feet per second per square mile) from State Road Fork occurred simultaneously with a stage of the Licking River equivalent to that of the flood of February 1939, a rise in the water surface curve of 2.5 feet at the upstream end of the works would result. Thus a freeboard of 3 feet above the maximum flood of record (February 1939) as confined by the levee would provide a freeboard of 0.5 foot at the upstream end of the works for this assumed condition.

IV. FLOOD HISTORY

42. *Past floods.*—Accurate information relative to past floods is practically impossible to obtain. Local testimony is not in close agreement as to floods of history, but steadfastly maintains that

[1] Not printed.

floods occur at least two to five times per year. Although no records are available as to the height which minor and moderate floods have reached, the occurrence of frequent flooding has been verified by investigation of newspaper files and reference to two diaries of local residents. Four floods, the elevations of which are known, have been studied by this office. They are those of May 1927, July 1938, February 1939, and July 1939. Of these four, the February 1939 flood was the most severe and the 1927 second in severity. The more frequent floods do not exceed a high-water elevation of approximately 849 feet (mean sea level) at the junction of State Road Fork and Licking River. This level has influenced the construction of homes and business places to the extent that the first floor levels are in general placed at this or higher elevations. Since the river banks are but 7 to 10 feet above the stream bed along the front of the town, overbank flooding from flashy run-offs on the Licking and its tributaries is frequent. The people accept floods as a natural event and prepare for them, when possible, by moving household goods, clothing, and merchandise to higher shelves and upper floors. However, the river stage is influenced radically by quick run-off from the drainage area above Salversville and frequently very little time is available to prepare for floods.

43. *Area subject to flooding.*—The Licking River is joined by two tributaries—Burning Fork and State Road Fork, just upstream from the heart of the business district of Salyersville. Immediately below the mouth of State Road Fork, the lower of the two tributaries, the Licking makes a wide bend to the left and passes the business district which is in its flood plain on the outside, or right bank, of the bend. It is this portion of town, including the main business section and the residences of about 500 of the 1,750 of the town's inhabitants which suffers the greatest damage from the frequent floods. The area is not large, as the width of the level valley bottom in which this portion of the town is built ranges from about 600 to 1,300 feet back from the river bank to the foot of the steep hills and extends only approximately three-fourths mile in length. A residential section known as Dixie, is located across the river and is on ground generally above the elevation of past floods.

44. *Analysis of flood damage.*—The analysis of flood damages sustained at Salyersville has been made by giving separate consideration to both tangible and intangible losses. Tangible losses or damages are those which inflict an immediate, monetary loss upon the inhabitants of the community, the amount of which can actually be ascertained or estimated with a reasonable degree of accuracy. Intangible losses or damages are those which adversely affect the health, life, and welfare of the inhabitants, but whose very nature render them almost impossible of direct evaluation. Tangible damages further subdivide into direct and indirect damages. Direct damages are considered to be those costs of replacement and restoration required to attain preflood conditions. These are the cost of replacing private and public property totally destroyed; the value of property, including merchandise, manufactured products, and raw materials, damaged or destroyed; and the cost of cleaning up and removing debris. Indirect damages are considered to be those consequential costs or losses, such as expenditures for rescue work and relief aid; the emergency costs of

fire, police, and military protection; the loss of revenue due to suspension of business and employment; the increased cost of maintaining utility services and communications and of transacting business during the floods; and the loss of rents from affected properties.

45. *Flood damage surveys.*—Flood damage surveys were made by this office relative to four floods, May 1927, July 1938, February 1939, and July 1939. These surveys are discussed below.

46. *May 1927 flood.*—The flood of May 1927 reached an elevation of almost 853.0 (U. S. Coast and Geodetic Survey datum). The low-lying portion of town which is subject to flooding by as little as 8 feet of rise, was caught without warning on this occasion when a rise of 15.7 feet was experienced. The damages incurred in this flood were established by house-to-house canvass (made in 1930) to have been $14,635. One death by drowning occurred in this flood. In January 1939 a study was made at Salyersville to determine the damages to be anticipated from a flood of like severity to that of 1927 should it recur. Present-day values and new developments considered, it is estimated that a repetition of the 1927 flood would cause $25,000 direct damage. This figure for direct damage represents only about 5¼ percent of the $475,000 estimated value of the buildings and structures in the affected portion of town. However, many buildings would not be damaged at all because reconstruction after the flood of 1927 and subsequent new construction have placed the first-floor levels of many buildings higher than the crest elevation of that flood. Very few buildings have basements. The new $100,000 school building, although located in the flood plain, is high enough to escape flooding except in the basement and heating plant.

47. *July 1938 flood.*—This high water reached an elevation of approximately 848 feet and was without great current, hence the crest of the flood was somewhat level throughout the flooded area. Water entered very few buildings, not more than a half dozen in all, and caused damage to personal belongings and structures estimated at about $500. It is estimated that 75 house lots and gardens suffered damage. Many of these gardens are plots of 1 acre or more and the monetary value of the crops is considerable when computed on the basis of small retail purchases at local stores to substitute for the ruined gardens. Using an average value of $25 per garden, large and small, the crop damage is estimated as having equaled $1,875. Although city water is available, many residents still draw their water from open wells. The cost of cleaning and inspection of these wells is estimated at $125 for 25 wells. A total of $2,500 direct damage is estimated to have resulted from this cropping season flood.

48. *February 1939 flood.*—The flood of February 3 and 4, 1939, was the greatest of record in Salyersville. The water level reached an elevation of 854 feet mean sea level, and overran the floors of business houses and residences in depths varying from 6 to 52 inches. Interruption of telephone service occurred but this was due to high water at Paintsville, Ky., 20 miles away, and was not the result of local damage at Salyersville. State Highway No. 40 was blocked at Salyersville and at points outside of Salyersville. The principal costs of restoring residential properties to their former condition consisted of replacing and repairing flooring that had warped, replacing broken windows, repairing doors and windows that had

warped out of shape, varnishing woodwork, replacing water-soaked furniture, replacing ruined plaster, and redecorating. With no industries, utilities, highways, railways, and no rural interests (considering Salyersville only) receiving serious damage, the estimated losses incurred in the February 1939 flood, obtained by a house-to-house canvass, are as follows:

Commercial:	
Buildings	$2,500
Stock and equipment	9,100
Residential:	
Buildings	6,800
Contents	10,200
Public:	
Buildings	1,600
Contents	9,100
Total direct damages	39,300

49. *July 1939 flood.*—Flooding in Salyersville occurred on July 5, 1939. State Road Fork, a tributary of the Licking River, contributed the major portion of the flood flow which caused damage to the town. Coal Branch, a tributary of State Road Fork, which drains a small area of less than 1 square mile immediately north of Salyersville and which joins State Road Fork just in the rear of the courthouse, discharged violently. This stream, seldom more than a trickle, and subject to backwater from State Road Fork, overflowed, damaging gardens and lawns along the north side of State Highway No. 40. An elevation of 851 feet (mean sea level) was reached by floodwaters in the vicinity of the courthouse and throughout the eastern part of town along State Road Fork. The western part of town, along the bank of the main stem of the Licking River, experienced a high water level of about 848 feet (mean sea level) and suffered very little damage to buildings. Damages resulting from this flood were obtained from a house-to-house canvass and inspection of crop damages. Eleven homes were flooded over their first floor level, damaging floors, walls, and in some cases, furniture. Although Salyersville has city water, many open wells are still used and flood water fouled at least 20 of these. A thorough cleaning was necessary to restore them to a sanitary and usable condition. The principal losses to the community in this flood were the gardens and crops, which constitute the main source of subsistence for many families. In general, the vegetable gardens are raised on the bank part of the house lots and additional plots of ground are planted to corn, soybeans, potatoes, or other crops to provide for winter needs and from which to obtain grain and forage sufficient to "winter" the family cow and a few chickens. Almost without exception, these latter-mentioned plots are located in the low, flat ground near the river and become practically a total loss when overbank flooding occurs. Appreciable damage resulted to textbooks stored for the summer in the depository of the Magoffin County Board of Education, located on the main floor of its office building at the rear of the courthouse lot. These damaged textbooks were condemned for public-health reasons and destroyed. Although water of elevation 848 feet did not overtop the wall around the new Salyersville High School, it did get into the basement where it damaged the furnace,

manual training tools, equipment, supplies, and other articles commonly kept in the basement. The investigation made at Salyersville subsequent to this flood reveal the following items of direct damage:

Buildings	$1,410
Furniture	450
Yards and wells	200
Other losses (clothing, books, tools, etc.)	1,080
Crops	2,000
Total direct damages	5,140

There are other damages, impossible of evaluation, sustained in each of the frequent high tides affecting this community. The resulting sanitation situation is acute. The rapid flow of floodwater scours the pits of open toilets, cleans the floors of hog houses and barns, reverses the flow of private sewer outfalls, and deposits filth all over the flooded area, in the shrubbery, in open wells, in houses, on school books, clothing, garden vegetables, canned goods, etc. In receding, the floodwater leaves this filth to bake in the hot sun and attract droves of flies to complete the distribution of germs to areas not within the flood zone.

50. *Evaluation of average annual flood damage.*—The determination of the annual damages accruing to the town of Salyersville, Ky., through repeated flooding of the Licking River and its tributaries is based upon the estimated flood damages which would obtain for floods of past record recurring under present-day conditions. Two major floods are known to have occurred during the 13-year period of record, 1927 to 1939, inclusive. These were: May 1927, elevation 853 feet, estimated direct damage $25,000; and February 1939, elevation 854 feet, estimated direct damage $39,300. The latter is the maximum of record. A fairly accurate record of other, less severe floods occurring during this 13-year period, has been compiled. A careful search through the files of past editions of the Salyersville Independent, Magoffin County's weekly newspaper, revealed dates of 11 high-water flows. Diaries, scrapbooks, and other personal documents were located in which other floods were recorded. In all, record was found of 48 floods having occurred within the past 13 years, 1927 to 1939, inclusive. Sufficient descriptive matter was found to enable a general subdivision of these floods into two groups; namely, floods occurring during the cropping season, and those occurring at other times. Further study differentiates the numerous smaller floods between those whose maximum high-water elevation exceeds 849 feet (at confluence of State Road Fork and Licking River) and those whose crest is less than 849 feet. Floods of elevation 849 and greater enter residences, business places, and public buildings, and do heavy damage. Floods of elevation less than 849, in general, do damage mostly to yards, wells, and crops. Damage surveys made subsequent to the floods of July 1938 and July 1939 reveal that the crop damage component for floods of any magnitude is about $2,000 for a first flooding during any cropping season. It is further evident that the damage to wells, etc., is practically as great for a mere bank overtopping as it is for a considerably larger flood. Therefore, a constant damage value has been assigned to floods whose elevations vary from bank top (elevation 846 feet) up to elevation 849 feet.

The value assigned is the estimated direct damage which occurs at stage 848 feet, equivalent to the flood of July 1938 (see par. 47). During the period of record 15 floods crested between elevations 849 and 851 feet (mean sea level). Twenty percent of these occurred within the cropping season. On the assumption that the amount of flood damage within this elevation range varies directly with the stage, it was determined that $1,800 was the mean damage for the group, exclusive of crop losses. Direct flood damages for all floods, except those of May 1927 and February 1939, are based upon the following values:

High-water elevation	Direct flood damage	
	Cropping season	Noncropping season
849 or above	$3,800	$1,800
Below 849	2,500	500

The data collected reveal that 15 floods occurred during the cropping season. However, only 6 of these did major crop damage, the other 9 being second, and even third, recurrences within the same seasons. Thirty-three high-water flows were experienced during noncropping seasons. In all, 2 flood crests exceeded elevation 851 (mean sea level), 15 fell within a range of 849 to 851 feet, and 31 were less than elevation 849 feet. In all instances where flooding occurred more than once per cropping season, it was assumed that no additional crop losses were sustained over and above the damage incurred by flood No. 1 of that particular season. However, due account was taken of damage other than crop losses which resulted. Obviously such procedure tends toward the determination of an annual damage value which is very conservative since it is entirely possible that 2 floods could occur within 1 cropping season so timed as to ruin 2 crops. The direct damage as computed from the floods of record, is summarized in the following table.

Direct flood damage, 13-year period of record

Description (elevations shown are feet, mean sea level)	Number	Direct damage		
		Crop	Other	Total
Floods below elevation 849	31	$4,000	$15,500	$19,500
Floods between elevation 849 and elevation 851	15	6,000	27,000	33,000
Floods above elevation 851	2	2,000	62,300	64,300
Total direct damage	48	12,000	104,800	116,800

From these data the direct damage due to flooding in Salyersville is estimated to have amounted to $9,000 per annum for the 13-year period of record. The indirect damages resulting from the floods are naturally difficult to evaluate. Due to the character of the community, which is principally a rural shopping center, the indirect damages would necessarily be considerably less than for a manufacturing center. Investigations made after the February 1939 flood revealed that the indirect damages which could be evaluated with

reasonable accuracy amounted to about 13 percent of the direct damages. Allowing for the various sundry items (see par. 44) it is estimated that the indirect damage should be at least 25 percent of the direct damage, exclusive of crop losses. The total average annual flood damage at Salyersville is, therefore, estimated to be $11,000. An evaluation of annual damages based upon the probability of future occurrence of floods at Salyersville is possible. However, in view of the inadequancy of available hydrological data and the remote sources from which discharge frequencies were adopted (see par. 2, appendix A),[1] it is believed that the determination of annual damages by the "frequency" method would be far less indicative of the actual conditions obtaining than by the "period of record" method herein employed.

51. *Annual benefits to accrue from flood protection.*—In evaluating the average annual benefits to be derived, cognizance has been taken of the increased land values which it is reasonable to believe will attend the future development within the protected area both because of normal future growth and the additional expansion induced by flood protection. It is highly improbable that extensive development will occur at Salyersville due to the absence of railroad facilities and the nature of the surrounding area. However, since Salyersville is a county seat, and since there exists considerable unimproved land within the portion of town considered for protection, it is reasonable to assume some development will take place. As a result of normal growth, induced expansion, and the appreciably greater land values which will obtain subsequent to the construction of buildings thereon, in contrast to present agricultural use, it is conservatively estimated that the annual benefits otherwise anticipated will be enhanced by at least 15 percent as of the midlife of the structures 25 years hence. The total annual benefits which would thus accrue to Salyersville are, therefore, estimated at $12,300.

V. IMPROVEMENTS DESIRED

52. *Local cooperation.*—The citizens of Salyersville, while probably in accord with practically any proposal for flood protection, are nevertheless limited in their ability to finance locally the costs of rights-of-way, damages, and other items as required by existing law in the execution of protective works for purely local control. It is believed that the residents of Salyersville will oppose any effort to increase their tax burden, now heavy as a result of financing their new $100,000 school building. However, the right-of-way and flowage requirements for protective works would be rather small. It is possible that contributions by landowners, coupled with efforts of the recently incorporated Licking River Flood Control Association, may constitute the necessary support required of local interests.

53. *Public hearing.*—A joint public hearing was held in Salyersville September 30, 1937, by the district engineer and regional conservator of the United States Department of Agriculture, in connection with the preliminary examination authorized by the Flood Control Act of 1936. Adequate opportunity was provided for presentation of local plans and ideas for relieving Salyersville of its flood menace. Therefore, no further public hearing has been conducted relative to the

[1] Not printed.

present investigation. The above-mentioned hearing was attended by 168 persons representing both agricultural and urban interests. The testimony presented was unanimous in its argument; namely, that the present floods occur several times each year, that extensive damage is incurred to buildings, furnishings, merchandise, crops, and livestock; that public health is menaced; that it is necessary to interrupt school and business pursuits; and that the protection from floods in this area is badly needed. Defense of the original location of the town site of Salyersville was made by reference to the greater depth of the river purported to have existed when the uplands were covered with virgin timber and prior to the present critical erosion.

54. *Suggested plans.*—Local interests advocated a plan of diverting the main stream of the Licking River by channeling or tunneling across the high land in the narrow divide at the bend of the river about 1 mile south of the town. They believe that such diversion, supplemented by channel dredging above and below town, will provide the desired relief from floods.

VI. PLAN OF DEVELOPMENT

55. *Possible methods of alleviating flood damage.*—The investigation of methods for flood protection for Salyersville, as covered by this report, is based upon protecting against a design flow of 14,000 cubic feet per second. The flood of February 3, 1939, the maximum of record, had a discharge of 14,000 cubic feet per second. A flow of this magnitude is computed to have a probability of recurrence of less than once in 100 years. The next highest flood of record (May 1927) reached an elevation of slightly less than 853 feet (mean sea level) and had an estimated flow of 11,000 cubic feet per second. Due to the little difference in crest elevation between the two floods, the consideration of protective works for floods less than 14,000 cubic feet per second does not appear practicable. Likewise, consideration of protection against flows greater than 14,000 cubic feet per second does not appear warranted because of the probable rare occurrence of such flows and because of the diminishing rates of return in flood-protection benefits which obtain for additional increments of project height. Studies made in connection with the investigation covered by this report include the following methods of alleviating the flood problem at Salyersville:

(*a*) Evacuation and resettlement.
(*b*) Retarding basins.
(*c*) Channel improvement.
(*d*) Diversion of flood flows.
(*e*) Protection by levees and flood walls.

The applicabilities of these respective methods are discussed in the paragraphs immediately following. In general, the findings of this report tend to reaffirm the conclusions of previous reports as to the feasibility of these methods.

56. *Evacuation and resettlement.*—The prospect of evacuation and resettlement of those portions of Salyersville which suffer from floodwater was studied. It was found that a better site could be located in the vicinity and that the development of this site presented no particular engineering difficulties. However, the transfer would involve

30 places of business, 7 public buildings, including a modern water-pumping plant and a new school building, and the dwellings which quarter approximately 500 people. Applying the cost figures derived from rather extensive studies of evacuation and resettlement made for other localities within the Cincinnati district subsequent to the flood of 1937 it is estimated that the cost of such a project at Salyersville would exceed $800,000. The ratio of annual costs to annual benefits would be approximately 1 to 0.5. Likewise, the evacuation and resettlement of any part of the town now subjected to frequent flooding, is economically infeasible.

57. *Retarding basins.*—Flood protection by a system of dams and retarding basins above town on the main Licking River and its three tributaries, State Road Fork, Burning Fork, and Coal Branch, was discussed by the District Engineer, Cincinnati, Ohio, in his report of November 25, 1931. In the study made at that time it was proposed to protect only against a flow of 10,000 cubic feet per second. The system of dams and retarding basins was considered capable of rendering the desired protection but was economically infeasible. The plan to retard only the main Licking River by a dam and retarding basin above town was pointed out as inadequate since State Road Fork, Burning Fork, and Coal Branch, collectively, were able to flood the town regardless of regulation on the main stream. The same reasons which eliminated the plan for dams and retarding basins in the studies of 1931 still obtain and apply even more pointedly when these works are to be increased sufficiently to provide protection against a flow of 14,000 cubic feet per second. Based upon the average annual benefits of $12,300 (see par. 51 above), plus additional benefit derived from areas not protected by levees, a capital expenditure of not more than $300,000 would be justified. The cost of even one reservoir would exceed this amount.

58. *Channel improvement.*—Flood protection against a flow of 14,000 cubic feet per second by channel improvement alone is not feasible. The topography of the river valley is such that Salyersville, as it is now located, is in the bottom of a natural flood reservoir formed by the gorging of the valley walls just below the town. The gradient of the Licking River reduces from 0.002 above Salyersville to a low of 0.00048 through the bend on which the town is situated. Hence, channel improvement notwithstanding, floodwater from above town would "pile up" in the low gradient section through town and continue to flood the valley. Any successful channel improvement would have to lower the grade and straighten the alinement at least through the gorge section about 1 mile in length. Such an improvement would entail a cost incommensurate with the benefits.

59. *Diversion of flood flows.*—Diversion of floodwater to other basins is impracticable because of topographical conditions. The Licking River makes a horseshoe bend at Salyersville. The town is on the outside of the bend and the minimum distance across the high divide at the peninsular neck between upstream and downstream reaches exists at a point about 1 mile south of Salyersville. (See pl. 2.) The most practical means of diverting the Licking River above Salyersville to a point below it would be by way of a tunnel through the divide at the narrow section. The height of the divide at this point is so great that an open cut would be more costly than

a tunnel. In a preliminary report submitted by the district engineer, Cincinnati, Ohio, on January 15, 1938, it was pointed out that tail water at the outlet would reach a minimum elevation 15 feet above low water at a design discharge of 9,000 cubic feet per second. Survey data indicate that the low-water elevations of tunnel inlet and outlet are approximately 839 and 834 feet (mean sea level), respectively. It follows, therefore, that the diversion so proposed will not affect the desired protection since tail-water influence alone would extend back into town at approximately elevation 849, which is the elevation above which water enters a majority of homes and business places. It follows that the discharge of the tributaries would supplement this stage and flooding would be practically as bad as at present. Even if the plan merited engineering endorsement, it is economically prohibitive. A plan to supplement the diversion tunnel with a barrier dam above its outlet to block off the backwater from town is untenable by reason of the impending flood potentialities of the tributaries whose discharges would be trapped behind the barrier dam. Provision to pump the flood-stage discharges of these tributaries over the dam is unreasonable. Hence, the suggested plan of diversion in reality amounts to a barrier dam above town with the diversion tunnel acting as an outlet works. Were the capacity of the outlet tunnel to be reduced to eliminate backwater flooding of Salyersville and the height of the dam increased to permit retention of flow, the scheme would become, in effect, a storage reservoir, a proposal which has been found to be unjustified.

60. *Levees.*—Providing protection against a maximum discharge of 10,000 cubic feet per second by construction of levees at Salyersville was found by the studies of 1931 and 1938 to be the method most probably feasible. In the light of recent data on flood potentialities, the current investigation is based upon protecting Salyersville against a discharge of 14,000 cubic feet per second (see par. 39 above). Several plans were studied.

Plan 1.—Levee protection for the area on the right side of the Licking River.

(*a*) Between Burning Fork and State Road Fork.
(*b*) Above Burning Fork.

Plan 2.—Levee protection for the main part of town lying to the right of State Road Fork and the Licking River.

Each of these plans is discussed below.

61. *Plan 1* (*a*).—This plan was studied in the two previous reports submitted by the District Engineer, Cincinnati, Ohio. Only four buildings occupy the 2.5 acres of land subject to flooding at this location. About 1,100 lineal feet of protective works would be required, of which approximately half would need to be flood-wall construction on account of inadequate clearance for levee construction. The right-of-way requirements for the levee section would reduce the remaining land area to about that occupied by the buildings and dissipate whatever agricultural value it may now possess. Two highway bridges and approximately 600 lineal feet of gravel-surfaced highway would have to be raised and two highway ramps constructed. The studies made in connection with this report confirm the findings of the previous investigations. The cost of protection for this small area would approach three times the value of the property protected. For this reason, plan 1 (*a*) is excluded.

62. *Plan 1 (b).*—The protection of the area on the right side of the Licking River immediately above Burning Fork would require approximately 2,000 lineal feet of 12- to 14-foot levee along the left bank of Burning Fork and about 1,500 lineal feet of 14- to 16-foot levee along the right bank of the Licking River. One highway ramp would be required if this plan were to be executed in conjunction with plan 1 (*a*), or two ramps if executed independently of that plan. The protected area would be approximately 25 acres when levee right-of-way is deducted. There are six homes in this area. The cost of levee construction, since such great length is required, is greatly in excess (at least three times) of the expenditure which would be justified by the anticipated benefits. Further consideration is, therefore, not accorded plan 1 (*b*).

63. *Plan 2.*—In the eastern part of town State Road Fork clings to the south side of its flood plain and close to the steep valley walls. The town has built up principally along the north half of the flood plain in this area with State Highway No. 40 located on the extreme north of the flood plain at the base of the valley wall. A levee originating from the embankment fill of Highway No. 40 near the upstream end of town, extending southward toward the channel of State Road Fork, curving downstream to practically parallel State Road Fork, and intersecting the embankment fill of State Highway No. 7, as shown on plates 3 and 4,[1] will confine State Road Fork to the south (left) side of its flood plain. Only one residence exists on the steep left bank opposite the proposed levee location. No plan is offered for protection of this residence which is somewhat higher than the majority of the dwellings in the flood plain on the right. The proposed protection of the lower portion of Salyersville from flooding by the Licking River would be accomplished by continuing the levee line across State Highway No. 7, thence along the right bank of the Licking River past the main part of town, and thence curving away from the river to close on the embankment fill of State Highway No. 40 near the lower end of Salyersville. The levee along the Licking River will not confine its flow to the extent that the levee confines State Road Fork in the upper part of town. The Licking River Channel at this point is somewhat in the center of its flood plain and the width of the overflow channel remaining after the levee is in place will be in excess of the river's average overflow channel width. Very few dwellings are situated in the low flood plain of the Licking on its left side at this point. Considerable acreage of excellent cropland exists for which no plan of protection is contemplated. The confinement of State Road Fork by the proposed levee will create a rise in the water surface near the upstream end of the levee estimated at 2.5 feet for a discharge of 7,000 cubic feet per second (see par. 41) on State Road Fork occurring simultaneously with the maximum flow of record on Licking River. The confinement of the Licking River on one side of its channel will raise the water an estimated 0.5 foot for a 14,000 second-foot discharge (maximum of record). The various details of this levee protection scheme follow.

64. *Foundation conditions.*—Auger borings along the trace of works reveal that the soil is alluvial and varies from clayey silt on the surface to sand below. The soil undoubtedly has bearing strength adequate

[1] Not printed.

for the works proposed. No positive cut-off wall is proposed but an item for ground-water treatment is included in the estimate.

65. *Type of works.*—The proposed protective works are to be compacted earth levee with top elevation 3 feet above the confined flow line for the maximum flood of record. The over-all length is approximately 4,700 feet. The section will have a crown width of 8 feet, and side slopes of 1 on 2½ for the river side and 1 on 2½ for the land side. Riprap sections on the river face of the levee will be used in three locations, near the head of the works on State Road Fork, near the mouth of Coal Branch, and along the bend of the Licking River for a distance of 1,650 feet below the mouth of State Road Fork. The proposed plan calls for approximately 600 feet of relocation of State Road Fork channel at the mouth of Coal Branch. At the downstream end of the works, a diversion ditch and 210 feet of reinforced concrete training wall are proposed to route the flow of a small branch around the point of the levee.

66. *Drainage.*—Three plans for the disposal of surface water (including the discharge of Coal Branch) from the protected area have been studied. One plan is to pump all run-off from the protected area during flood stage and to divert the flow of Coal Branch (drainage area 267 acres) around the upstream end of the levee by means of a concrete diversion channel. Another plan is to collect and pump the internal drainage as above, and confine the discharge of Coal Branch to a pressure conduit along its present channel. The third plan proposes to collect all run-off including the discharge of Coal Branch (total drainage area 368 acres), pump it out of the protected area during flood stage, and bypass it through flood gates during low-water flows. The first plan entails installation of pumping equipment having a capacity approximately 30 percent as great as that required for the third plan wherein it is proposed to pump the entire run-off. In addition an earth-fill dam of approximately 8,000 cubic yards with spillway, sluice gate, 1,400 lineal feet of concrete diversion ditch, and necessary rights-of-way are involved. The second plan was subdivided to consider two optional lengths of pressure conduit for handling the discharge of Coal Branch. In one case the conduit extends to State Road Fork and discharges into it after underpassing the levee. In the other case the pressure conduit terminates just in rear of the buildings on the south side of Kentucky State Highway No. 40 and the alinement of the levee is altered to follow the banks of Coal Branch from its mouth upstream to join a head wall at the conduit outlet. In either case it is necessary to construct an earth-fill dam across the narrow valley at the head of the pressure conduit (approximately 800 feet upstream from Highway No. 40). This dam would be similar in size and location to the dam required in the plan to divert Coal Branch. The second plan with either length of conduit involves pumping requirements in excess of the first plan. The surface water draining from the hill in rear of the east part of town would be intercepted by the diversion ditch in the first plan, whereas in this plan it becomes part of the internal drainage which must be pumped from the protected area during flood periods. Also, additional facilities are required to deliver the collected internal drainage to the pumps. The third plan which proposes to pump, during flood stages only, all run-off coming into the enclosed area, Coal Branch included, can be constructed at a cost 10 percent less than to divert

Coal Branch and 20 percent less than the plan to incorporate either the full length conduit or the shorter conduit with its necessary levee revisions. Investigations made in connection with the disposal of internal drainage by pumps alone (see appendix B)[1] indicate that the damage which might result from impounding the collected run-off within the protected area is insufficient to justify installation of pumping facilities designed to discharge either all or part of this drainage. However, conservative engineering practice would appear to dictate that certain minimum pumping requirements be provided in situations of this nature. Therefore, a pumping installation capable of discharging 40 cubic feet per second (approximately 0.1 inch run-off per hour) against a maximum head is proposed. The pump house is to be situated at the mouth of Coal Branch toward which point a considerable amount of the internal drainage naturally flows. The construction of 500 lineal feet of 42-inch concrete pipe interceptor will be required to deliver to the pumps the internal drainage from the area west of State Highway No. 7. Electric power now available at Salyersville appears to be adequate to handle the proposed pumping installation. However, in the final design it may be necessary to increase the capacity of present transmission lines in addition to providing extensions to serve the pumps. Allowance has been made for this contingency in estimating the pumping installation costs.

67. *Traffic facilities.*—Since highway grades through Salyersville have been raised to an elevation considerably above the flood plain of the river, it is possible to overcome the grade differential between levee and highway by constructing ramps to carry the highways over the levee. At the upper end of the levee in the eastern part of town, no alteration of the existing highway grade is necessary on State Highway No. 40. At the point of intersection of Highway No. 7 and the levee, a ramp is proposed to carry the highway over the levee 6.5 feet above present grade. A similar ramp of less height will be required at the downstream end of the levee where it crosses State Highway No. 40.

68. *Right-of-way.*—Sufficient width of right-of-way for construction of the proposed levee is available throughout its entire length except for the passage in rear of the new school building where a crib wall is to be used on the land side.

69. *Cost analysis.*—The estimated costs of construction, annual charges, and annual benefits are given below for three respective project heights of plan 2 which involves protecting Salyersville by levees.

Item	Elevation of levee top at upstream end (feet, mean sea level)		
	856.5	857.5	858.5
Construction costs	$163,000	$174,000	$185,000
Rights-of-way and damages	12,000	12,000	12,000
Total cost	175,000	186,000	197,000
Annual cost	8,900	9,500	10,000
Annual benefits	11,300	12,300	12,300
Ratio annual cost to annual benefits	1 to 1.27	1 to 1.30	1 to 1.23

[1] Not printed.

70. *Summary.*—Based upon the findings of this report, flood protection for only the main part of Salyersville appears worthy of consideration. Evacuation of all or part of the town would cost in excess of the sum merited by the anticipated benefits. Protection of the entire town by a system of reservoirs located upstream on the Licking and its tributaries has been found economically impracticable. A single reservoir located upstream on the Licking River is both inadequate and uneconomical. Diversion of the Licking River at a point south of Salyersville does not provide the desired protection since it leaves the town unprotected from the flood discharges of Burning Fork and State Road Fork tributaries. Flood protection for Salyersville cannot be provided by improvement of the Licking River channel. Topographic conditions, the location of the town in the broad flood plain, and the influence of the gorge section of the river below the town combine to preclude this method. Levee construction will provide the required protection and has no objectionable engineering features. Protection of the entire town would require plans 1 (a) and 1 (b) and 2 in combination. Plans 1 (a) and 1 (b) are not economically justified as was pointed out in paragraphs 61 and 62. Eliminating plans 1 (a) and 1 (b), it is found that plan 2 alone provides the most feasible scheme of flood protection for Salyersville. The figures presented in paragraph 69 above reveal that flood protection to a levee top elevation of 857.5 feet (mean sea level) is at the peak of economic feasibility.

VII. OTHER SUBJECTS

71. *Other subjects.*—Since the only feasible method of flood protection for Salyersville consists of levees, such possible incidental features as water supply, hydroelectric-power development, and conservation do not come within the purview of this report. Navigation of the Licking River exists only about 3 miles above its mouth. No longer is any traffic of logs or rafts carried by the river at or above Salyersville. It is highly improbable that any improvement of the upper reaches of the Licking River for navigation will ever be undertaken. Irrigation is not a problem in an area which receives over 40 inches of rainfall yearly. Silting of the river since early times has apparently been considerable. However, no appreciable silting during the past 9 years can be detected by comparison between channel sections as surveyed in 1930 and 1939, respectively. There is a growing tendency among farmers to restore to grazing land some of the steeper slopes formerly cultivated and from which practically all topsoil has been eroded. It is believed that perhaps even less silting may be expected in the future. Recreational facilities will not be directly benefited from flood-protection works at Salyersville. However, the elimination of the frequent flooding, now common, will greatly enhance the general sanitation of the community.

VIII. SUMMARY AND CONCLUSIONS

72. *Summary.*—Salyersville, Ky., is subject to damaging floods from the Licking River and from Burning Fork and State Road Fork, two tributaries which enter the Licking River at Salyersville. Two

serious floods have occurred in the last 13 years which practically inundated this community. Moderate floods which damage a few buildings and ruin garden plots are very frequent, sometimes occurring as often as two and three times a year. Based upon a rather extensive flood damage survey, it is estimated that the average annual tangible flood damage (direct and indirect) in the principal section of the city, amounts to $11,000. The intangible damages, such as menace to health by reason of unsanitary conditions, are believed to be very material. All of the various methods by which flood protection is usually accomplished have been considered for Salyersville. Evacuation of the affected area is economically infeasible. Protection by reservoir would call for the construction of at least two reservoirs because either the Licking River itself, or the combined flows of Burning Fork and State Road Fork, can cause floods at Salyersville. The capitalized annual benefits to be derived would be much less than the cost of one reservoir. Similarly, diversion of the Licking River above Salyersville to a point below that community was found to be inadequate under any condition. The protection of Salyersville by channel improvements would involve not only the improvement of the channel at Salyersville but for the entire length of the gorge section (about 1 mile) below town. It is evident that enlargement of the channel over such an extended reach would be extremely costly. The only practicable method of protecting Salyersville is by the construction of levees, this construction being limited to the principal section of the town. The areas above Burning Fork and between Burning and State Road Fork contain such a small amount of development for the great length of protection works required that protection is not economically justified. The protection of the main section of town against the maximum flood of record (14,000 cubic feet per second) from a point about 2,400 feet upstream on State Road Fork to a point on the Licking River about 1,700 feet downstream of the mouth of State Road Fork can be accomplished by the construction of a levee averaging 13 feet in height with top elevation at 857.5 feet (mean sea level) at the upstream end. The total cost of such protection is estimated at $186,000, of which $174,000 is for construction and $12,000 for rights-of-way and damages. The annual cost is estimated to be $9,500, and the annual benefits $12,300.

73. At the public hearing held on September 30, 1937, in connection with the preliminary examination of the flood situation at Salyersville, no local cooperation was tendered. Although it is believed that residents of Salyersville would oppose any increase to their now heavy tax burden, it is possible that contributions by landowners, coupled with the efforts of the recently incorporated Licking River Flood Control Association, may meet the requirements of local cooperation.

74. *Conclusion.*—The district engineer concludes that:

(*a*) Protection for the town of Salyersville be limited to that portion lying along the right bank of State Road Fork and along the Licking River below State Road Fork, and be accomplished by the construction of a levee.

(*b*) Protection against a design flood of 14,000 cubic feet per second on the Licking River will be adequate.

(*c*) Local cooperation be required to the extent of providing necessary rights-of-way, drainage facilities to the pumps, road changes, and maintenance and operation subsequent to completion of the works.

(*d*) The Federal Government should provide all necessary funds for construction of the levee and pumping facilities.

IX. RECOMMENDATIONS

75. *Recommendations.*—The district engineer recommends construction of a levee and the necessary drainage facilities at Salyersville, Ky., at an estimated Federal expenditure of $174,000 to be allotted in total for construction in 1 year. He further recommends that local cooperation be required to the extent of providing all necessary rights-of-way, drainage facilities to the pumps, road changes, and maintenance and operation subsequent to completion of the works.

FRED T. BASS,
Major, Corps of Engineers,
District Engineer.

[First endorsement]

OFFICE, DIVISION ENGINEER, OHIO RIVER DIVISION,
Cincinnati, Ohio, May 16, 1940.

To the CHIEF OF ENGINEERS, UNITED STATES ARMY.

1. The district engineer presents a plan for flood protection at Salyersville, Ky., by means of levees with the necessary drainage facilities for the disposal of interior run-off.

2. The annual tangible benefits credited to the proposed project are based on elimination of annual damages computed from past flood occurrences during the 13-year period 1927 to 1939, inclusive, with adjustments for present-day values and anticipated future development within the protected area. It is realized that an estimate of annual damages based on such a short period of record is subject to question on the score that it is not truly representative of the annual damages that may obtain over a longer period of years. However, the district engineer has utilized all readily available data in arriving at his estimate of damages and points out in his report that, in view of the unreliable nature of the frequency studies for this vicinity, the alternative of an estimate of annual damages based on computations of the theoretical frequency of flooding would be misleading. The division engineer believes, therefore, that the annual damages as presented in the district engineer's report are not susceptible to more accurate evaluation from the data available at this time.

3. The division engineer notes that the pumping capacity proposed for the disposal of interior run-off allows for ponding in the area protected by the levee. Damages estimated at $600 annually, which would result from this proposed ponding, should be deducted from the gross benefits credited to the proposed improvement. Taking this feature into account, the total annual benefits to the project are $12,300 less $600, or $11,700, and the ratio of cost to benefits, 1: 1.23.

4. In connection with the pumping capacity proposed by the district engineer for the disposal of interior run-off, it is noted that, if necessary, a substantial increase in capacity could be provided at a small additional cost. The division engineer believes that the estimate of cost for the entire project is ample to take care of any additional pumping capacity that may be considered desirable after the more detailed studies preceding construction are made.

5. After full consideration of data presented in the district engineer's report, and in view of the flashy nature of the stream and the past

loss of life and property in this locality, the division engineer believes that protection from flooding of Salyersville as proposed by the district engineer is justified by the tangible and intangible benefits that would accrue to such a project.

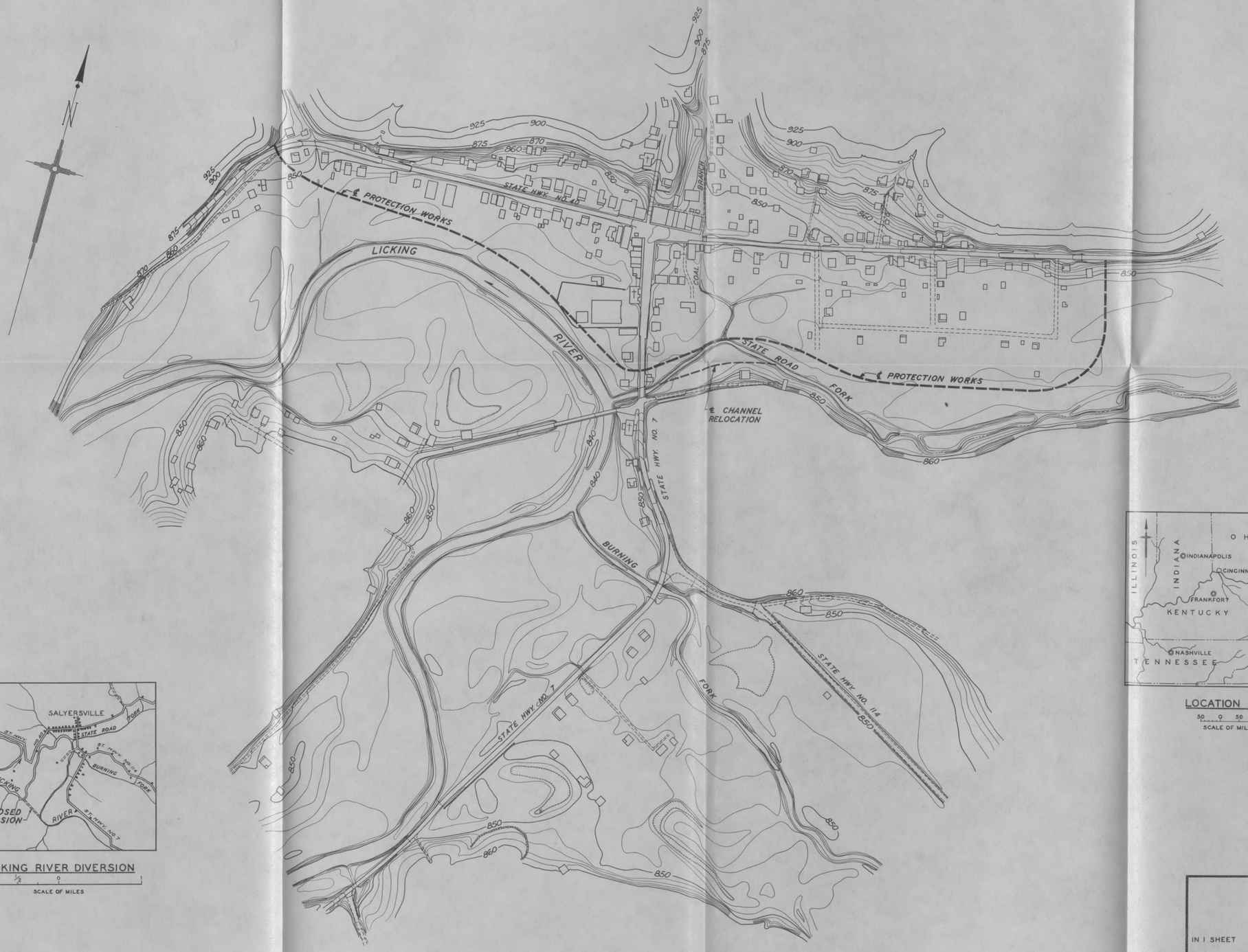
6. The division engineer, accordingly, recommends adoption of a project for the protection from floods of Salyersville, Ky., consisting primarily of levees with necessary drainage facilities, at a cost to the United States of $174,000.

7. He also recommends that no money shall be expended on the construction of the project until responsible local agencies have given assurances satisfactory to the Secretary of War that they will (*a*) provide without cost to the United States all lands, easements, and rights-of-way necessary for the construction of the project; (*b*) provide without cost to the United States all necessary road pavement at levee crossings and the drainage facilities necessary to convey interior run-off to the pumping plant; (*c*) hold and save the United States free from damages due to the construction works; (*d*) maintain and operate all the works after completion in accordance with regulations prescribed by the Secretary of War.

E. H. Marks,
Colonel, Corps of Engineers,
Division Engineer.

WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY



LICKING RIVER DIVERSION

½ 0

SCALE OF MILES

LOCATION MAP

50 0 50 100

SCALE OF MILES

FLOOD PROTECTION
SALYERSVILLE
LICKING RIVER, KENTUCKY
GENERAL PLAN

IN 1 SHEET | SHEET NO. 1 | SCALE: 1"=400'

200' 0 200' 400'

U. S. ENGINEER OFFICE, CINCINNATI, OHIO, AUGUST, 1939

SUBMITTED: E. A. Lindsley, ENGINEER

APPROVAL RECOMMENDED: R. C. Wolf, SR. ENGINEER, CHIEF, ENGINEERING DIVISION

APPROVED: Earl T. Bar, MAJOR, CORPS OF ENGINEERS, DISTRICT ENGINEER

TO ACCOMPANY REPORT DATED: MARCH 30, 1940

DESIGNED BY A.F.A.
DRAWN BY F.C.D.
TRACED BY C.L.G.
CHECKED BY F.W.

FILE NO. O-13-R35-18/2

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PLATE 2